SATURDAY, AUGUST 14, 1880.

CONTRIBUTIONS TO ENCEPHALIC ANATOMY.

BY E. C. SPITZKA, M.D.

Having, through a piece of good fortune, come into the possession of a living iguana, and thence obtained the brain and cord in a perfectly fresh condition, I was enabled to make a study for the first time of the remarkable brain of this saurian.

As regards the exterior of the encephalon, it presents nothing very different from that of any other higher reptile. On a lateral view, however, it exhibits a much acuter basilar incurvation, approximating to the bird's brain in this respect. As in birds, also, the optic nerves leave the skull directly on emerging from the chiasm. It is remarked also that the optic lobes are far larger than in any reptile or bird thus far examined by anatomists; in fact, excluding the case of the finny tribes, it may be said that the iguana possesses the largest optic lobes in the animal kingdom. They are as massive in their grey and white tissues, and nearly as voluminous as the cerebral hemispheres.

The olfactory lobes and bulbs offer nothing special for consideration.

On a transverse section through the cerebral hemispheres, I am able to identify the component parts of the cornu ammonis of the mammalia. It appears that the medial thin wall of the cerebral vesicle corresponds, with its layer of closely packed pyramidal nerve cells, to the *stratum corporum nervorum arctorum* of Kuppfer, and it is indeed separated from the cortical layer of the convexity, which I believe to correspond, as far as the thin part extends, to the *sigma* of the cornu. At the lower end of the thin-walled vesicle, where a transition of nerve fibres from the *stratum corporum nervorum arctorum* (?) takes place, to the thalamus, and which therefore corresponds to the fornix, there is an accumulation of molecular nerve substance, projecting outwards into the ventricular cavity. This may represent one of the thalamic tubercles; I regard it as much more probable, however, that it corresponds to the body of the so-called fascia dentata.

Now, in sections exhibiting the above features, I find also another which is highly important, in so far as it tends to overthrow another one of the *dicta* on whose strength the sauropsidean and mammalian brains are distinguished. Immediately underneath the median longitudinal fissure, but *over* the third ventricle, there passes a fasciculus of white fibres, uniting the two hemispheres, and particularly that portion of each which corresponds to the cornu ammonis. This is unquestionably the corpus callosum, whose first appearance in the embryo and the lower mammalia we know to be intimately associated with the development of the cornu ammonis.

But it is when we reach the mesencephalon and the region posterior to it, that we discover the most remarkable features of this brain.

As in some other saurians, the cerebellum instead of being curved backward, and constituting a cap over a part of the lateral ventricle, as in the alligator and chelonia, is bent forward, and bound to the posterior face of the optic lobes by the arachnoid filaments. On separating and drawing it backward, thus making it correspond artificially in position with the cerebellum of the alligator, we find that between the optic lobes and the cerebellum there are two pairs of tubercles.

One of these pairs, which I have found as a concealed mass in turtles, and as a very distinct elevation in the alligator, ophidia and pseudopus, I was familiar with, and I had no hesitation in describing it as the post-optic ganglia corresponding to the posterior pair of the corpora quadrigemina. The other was at first new to me, but after a careful comparative study I found that it was nothing but an unusually large, and therefore more prominent representative of a ganglionic mass which I have noticed in fair development in the turtle, and which is even represented in an atrophic condition with the mammalia. As the pair of tubercles in the iguana lies intermediate to the optic and post-optic lobes, I propose for it the name of inter-optic lobes.

On a dorsal view these different parts lie about as follows: In front are the massive optic lobes touching each other broadly on the middle line, so that their posterior margins form a continuous semi-lunar curve, convex behind. Behind each optic lobe, and bulging out somewhat, laterally, we have the smaller but distinct post-optic lobes, which fail to come in contact in the median line, so that a shallow groove would separate them, if it were not filled out by another structure now to be described.

If we imagine the median furrow separating the optic lobes prolonged between the post-optic lobes, and crowd two little pea-shaped eminences on each side of this imaginary median line, so that the latter are bounded in front by the optic lobes, on the outside by the post-optic lobes, and behind by the cerebellum, we will have the precise situation of the inter-optic lobes. These eminences are not so remarkable for their absolute size (their surface extent being only half that of the optic lobes) as for the distinctness of their demarcation. I have obtained sections through their posterior third, in which these bodies are shown to be absolutely free.

Other sections further forward show that these ganglia crop out of a specialized division of the central tubular grey of the aqueduct, and that the visible eminences do not represent the true extent of the ganglia.

The trochlearis nerves arise behind the inter-optic lobes, and passing forwards and downwards, lie in the furrow between the optic and post-optic lobes, as in other reptiles. It is well known that in the mammalia they pass down behind the post-optic lobes. I look on this as an incidental and insignificant variation.

The remainder of the isthmus shows nothing especially noteworthy. The remarkable size of the oculo-motor nuclei, and the gigantic dimensions of their almost star-like multipolar nerve-cells, merits mention, as well as the fact that in this animal the nuclei of the third and fourth pairs constitute a common cell mass, unlike the relation in the mammalia, and that the third and fourth pairs arise almost in the

same plane, the third from the ventral, the fourth from the dorsal extensions of the common nucleus.

I would call attention to the fact that the average dimensions of the cell nuclei of the auditory nerve nucleus equal those of the motor nuclei of the medulla and cord, and exceed some of them, and that the same statement applies to the cells as a whole. I make this statement in view of the recent communication of Dr. Mason before the American Neurological Association, though I do not claim to make it on the same basis of careful and extensive micrometric observations that his communication was based on, but on a general impression derived from repeated examinations which I think are sufficient to determine palpable differences.

The present preliminary report is taken from a communication made by me to the *Journal of Nervous Diseases* for last June, but I trust before long to submit to your readers a more exhaustive and illustrated record of this interesting and suggestive piece of cerebral anatomy.

DRY "MOUNTS" FOR THE MICROSCOPE.

BY PROFESSOR H. L. SMITH, HOBART COLLEGE, N. Y.

II.

In a former paper, SCIENCE No. 3, I made a few remarks upon this subject, and described the methods which I had found tolerably successful, viz.: the rings made of shellac and lampblack, and those punched out of gutta-percha tissue. The former appear to answer quite well, and the changes, if any, are very slight, yet I have, in a very few cases, observed a deterioration after the lapse of a year or so, probably from imperfect manipulation. Although I have not myself observed any great change in the gutta-percha mounts, I am not certain that they will stand prolonged use with immersion objectives without injury. I have mounted many specimens of delicate test objects for the Messrs. Spencer, and they are decidedly of the opinion that the shellac ring is the better for durability, and I am informed by Mr. Gundlach that the gutta-percha ring will not stand cedar oil. Mr. Phin has suggested that in time the gutta percha tissue will disintegrate. I have not yet noticed this, and do not think it will happen under the cover of a "mount" especially if protected by a ring of cement subsequently applied. If, however, such disintegration does, in time, happen to the tissue, this will be a great objection to its use. I have found that the "tissue" becomes so charged with electricity by handling, and also by the punching, that it interferes seriously with the latter operation, and thus makes it necessary to place strips of the "tissue" on thin moistened strips of paper, and to punch out both at the same time. The preparation of the shellac rings by the turn table obliges one to keep on hand a large stock all the time to insure perfect drying, and to have them always ready. I am obliged to have some 1000 or 1500 on hand in advance, and this necessitates a considerable outlay in stock, which will not always be convenient for amateurs. For the above reasons I now propose a new process which appears to meet all the desired wants, and which combines the advantages of the shellac cement and the gutta-percha rings.

The very simplicity of this process causes me to wonder why it was not thought of before. I take a sheet of thin writing paper, white or colored, and dip it into thick shellac varnish (shellac dissolved in alcohol), and hang it up to dry. When thoroughly dry it should have a good glaze of the varnish on it (different thickness of paper can be used according to depth of cell required). Out of this shellac paper I cut my rings, and these can be made in any quantity, and kept for any time. The process of mounting is simple. The slide is cleaned, and the flat paper ring placed in the centre; on this the cover is placed, having the object dried on it, and the two are held together by the forceps and gently warmed; this serves to attach the ring to the slide, and cover, at several points, so that the forceps may now be laid aside. The next step is to take a glass slip, (another slide), and laying this on the cover, to grasp the two slides at each end by the finger and thumb of the two hands, and pressing them tightly together, to warm the slide gently; by looking at the ring obliquely, on the under side, one can tell at once, when all the air is pressed out, and the adhesion is complete between the cover and the ring, and also the ring and the slide, and they must be held together a moment or two to cool. If the lac is sufficiently thick on the paper the adhesion takes place quickly, and with moderate heat, and there will be no danger of breaking the cover, unless it has been warped in the process of warming, which will sometimes occur when very thin glass has been heated too much for the purpose of burning off the organic matter, or when the support is too small in diameter, or when it is not flat. I think I may be able to induce the leading opticians to manufacture this paper and also the rings for sale; for special purposes the paper might be printed beforehand, so that, when mounted, the ring would show on the under side the name of the preparer, or of the object. I cannot conceive of anything more satisfactory than these rings. Many large objects which would be crushed if one used only the shellac rings made on the slide, by the use of the turn table, by the giving way of these by softening, and under the necessary pressure for attaching the cover, are perfectly protected by the paper rings. I am satisfied that the balsam mounts will be much less frequently used, as soon as we can find some *sure* dry process. The diatoms, as a rule, show much better when mounted dry, and with whole frustules, exhibiting both the side and the front view, also the mode of attachment, etc. The dry mounts are certainly to be preferred when they are desired for anything except pretty objects, and even for this latter purpose there is often a very great difference in favor of the dry mount. Although I have not used these shellac paper rings for any very great length of time, yet I can see no reason why they should not be equal to the simple shellac ring for durability, and very much superior to it in other respects.

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SCIENCE AT BREAKFAST.

By The Editor.

The sterling goodness of Dr. Johnson's heart, notwithstanding many apparently blunt demonstrations to the contrary, was never more clearly demonstrated, than when he remarked to Boswell, " I encourage this house, for the mistress of it is a good civil woman, and has not much business."

The house referred to was the "Turk's Head Coffee House." But coffee houses, nay coffee drinkers, have much changed in outward form since the days of the sturdy old philosopher. The beau and the belle no longer, in picturesque costumes, discourse scandal, sipping the Eastern beverage from exquisite specimens of china ware, and tea and coffee, no longer a luxury, are now enjoyed by the toiling millions, and esteemed a blessing by all classes.

Although tea and coffee is universally used by the civilized nations of the world, few understand the natural potent properties of these substances, or are even conscious of their powerful action upon the human system, and as it is a subject interesting to so many, I offer the following sketch, treating of the more important points.

Coffee, tea and chocolate all contain in common a nitrogenised basis, to which they owe most of their important chemical properties. Tea and coffee even contain the self-same basis, denominated indiscriminately *theine* or *caffeine*. In chocolate the cocoa principle called *theobromine* is richer in nitrogen than the *theine*.

The chemical constituents of these substances are as follows : While in tea the basis is combined with tannic acid, in coffee it forms a salt, with a peculiar tannic acid, containing a greater proportion of nitrogen, which together with tannio-caffeic acid is united with potash into a so-called double salt. Tanno-caffeic acid when roasted, develops the agreeable odor of coffee.

Not only the same basis, but also two similar organic acids, one contained in tea, the other in coffee, increase the conformity, between the leaves of the former and the beans of the latter.

Legumin, cellulose, gum, sugar, citric acid in addition to oleine, and what is called palm-fat, accompany the organic acids and the theine of the coffee beans.

But the tea leaves, apart from the basis and the acids, are composed of albumen, cellulose, gum and wax, the green pigment of the plant and the volatile oil of tea

This peculiar oil is the principal source of the aroma of tea, by which, in spite of the conformity between tea and coffee, it essentially differs from the latter.

The inorganic constituents of tea and coffee are moreover different. While in coffee, chlorine, phosphoric and sulphuric acids are combined with potash, lime, magnesia and oxide of iron ; tea contains another inorganic acid besides, consisting of manganese and a large proportion of oxygen.

So much for the chemical constituents of coffee and tea. Let us now examine their peculiar properties and nutritive qualities.

Chocolate from its large proportion of albumen is the most nutritive beverage, but at the same time from its quantity of fat, the most difficult to digest. But its aromatic substances strengthen the digestion. A cup of chocolate is an excellent restorative and invigorating refreshment even for weak persons, provided their digestive organs are not too delicate. Cardinal Richelieu attributed to chocolate his health and hilarity during his later years.

Tea and coffee do not afford this advantage. Albumen in tea leaves, and legumin in coffee berries, are represented in very scanty proportions, for while in the former the albumin is coagulated by boiling water, in the latter the legumin is prevented from being dissolved by the lime with which it is combined.

The praise of tea and coffee as nutritive substances is, therefore, hardly warranted, because, as restoratives for the body, the alimentary principles and not the elements are to be taken into account. The former principle cannot be ascribed to "Theine," which is excreted again as urea with surprising rapidity, and to this swift transformation tea and coffee owe their diuretic action, which is considerably assisted by the warm water of the infusion.

Tea and coffee, though of themselves not difficult of digestion, tend to disturb the digestion of albuminous substances by precipitating them from their dissolved state. Milk, therefore, if mixed with tea or coffee, is more difficult of digestion than if taken alone, and coffee alone without cream promotes digestion after dinner by increasing the secretion of the dissolving juices.

The volatile oil of coffee and the empyreumatic and aromatic matters of chocolate *accelerate* the circulation, which, on the other hand, is *calmed* by tea.

Tea and coffee both excite the activity of the brain and nerves.

Tea, it is said, increases the power of digesting the impressions we have received, creates a thorough meditation, and, in spite of the movements of thoughts, permits the attention to be easily fixed upon a certain subject ; a sense of cheerfulness and comfort ensues, the functions of the brain are set in motion, the thoughts are concentrated and not apt to degenerate into desultoriness.

On the other hand, if tea is taken in excess, it causes an increased irritability of the nerves, characterized by sleeplessness, with a general feeling of restlessness and trembling of the limbs ; spasmodic attacks may arise, with difficulty of inspiration in the cardiac region. The volatile oil of tea produces heaviness in the head, first manifesting itself in dizziness and finally in stupefaction.

These symptoms have been called an evidence of a real tea intoxication. Green tea, which contains much more of the volatile oil than the black, produces these obnoxious effects in a far higher degree than the latter.

While tea principally revives the faculty of judgment, and adds to this activity a sensation of cheerfulness, coffee acts also on the reasoning faculties, but without communicating to the imagination a much higher degree of liveliness.

Susceptibility to sensuous impressions is intensified by coffee ; the faculty of observation is therefore increased, while that of judgment is sharpened, and the perceptions adopt more quickly certain forms, activity of thoughts and ideas is manifested, a mobility and ardor of wishes and ideals, which are more favorable to the shaping and combination of already premeditated ideas than to a calm examination of newly originated thoughts.

Coffee, also, if taken in excess, produces sleeplessness and many baneful effects very similar to those arising from tea drinking. Coffee, however, produces greater excitement, and a sensation of restlessness and heat ensues. For throwing off this condition fresh air is the best antidote.

Much depends upon the proper roasting of coffee, in which process it loses weight but increases in bulk, two pints of unroasted berries giving three pints when roasted.

Several empyreumatic substances created by roasting produce the reddish or brown color, and the tanno-caffeic acid, altered by roasting, produces the aroma ; the sugar loses a part of its amount of hydrogen and oxygen, and is thus decomposed into burnt sugar or caramel.

Liebig states that the berries should be roasted until they are of a dark brown color. In those which are too dark there is no caffeine ; and if they are roasted black, the essential parts of the berries are entirely destroyed, and the beverage prepared from them does not deserve the name of coffee. This fact should be noted by drinkers of *caffe-noir*.

The berries of coffee when once roasted, lose every

hour, somewhat of their aroma in consequence of the influence of the oxygen of the air, the porosity of the roasted berries allowing it to penetrate easily. Liebig recommended a process by which much of this pernicious change can be avoided. "Strew," says he, "over the berries, when the roasting has been completed, and while the vessel in which it has been done is still hot, some powdered white or brown sugar; half an ounce to one pound of coffee is sufficient."

The sugar melts immediately, and by well shaking, or turning the roaster quickly, it spreads over all the berries, and gives each one a fine glaze, impervious to the atmosphere.

They have then a shining appearance, as though covered with a varnish, and in consequence lose their odor entirely, which, however, returns in a high degree, as soon as they are ground.

After this operation, they are to be shaken out rapidly from the roaster, and spread on a cold plate of iron, so that they may cool as soon as possible.

If the hot berries are allowed to remain heaped together, they begin to sweat, and when the quantity is large, the heating process by the influence of the air increases to such a degree, that the coffee is permanently damaged."

In this city I have often observed that coffee is roasted to too high a color, and filled into sacks too quickly, before the process of cooling is complete.

The preparation of coffee as a beverage is accomplished by three processes: first, by *filtration;* second, by *infusion;* and third, by *boiling*.

Liebig states that filtration gives often, but not always, a good cup of coffee. When pouring the boiling water over the ground coffee is done slowly, the drops in passing come in contact with too much air, whose oxygen works a change in the aromatic particles, and often destroys them entirely.

The extraction moreover is incomplete; instead of 20 to 21 per cent., the water dissolves only 11 to 15 per cent., and 7 to 10 per cent. is lost.

Infusion is accomplished by making the water boil and then putting in the ground coffee, the vessel being immediately taken off the fire and allowed to stand quietly for about 10 minutes.

This method gives a very aromatic coffee, but one containing very little extract.

Boiling is the custom in the East, and yields excellent coffee. The powder is added to the water when cold, and then placed over the fire and merely allowed to boil a few seconds. The fine particles of coffee are drunk with the beverage. If boiled long, the aromatic parts are volatilized and the coffee is then rich in extract, but poor in aroma.

Further, Liebig gives what he calls the best method; th s I produce, not because I think the plan will make a coffee acceptable to most palates, but because Liebig speaks highly in its praise, and states that it is without those heating properties, common to most preparations, causing it to be rejected by many in delicate health.

"My method," said Leibig, "is the union of the second and third. The usual quantities of coffee and water are to be retained; a tin measure containing half an ounce of green berries, when filled with roasted ones, is generally sufficient for two small cups of moderate strength, or one so-called breakfast cup; one pound of green berries, equal to 16 ounces, yielding after roasting 24 tin measures (of ½ ounce each) for 48 small cups of coffee.

With three-fourths of the coffee to be employed, (after being ground), the water is made to boil for 10 or 15 minutes.

The one-quarter of the coffee which has been kept back, is then flung in, and the vessel immediately withdrawn from the fire, covered over and allowed to stand from five to six minutes.

In order that the powder on the surface may fall to the bottom, it is stirred around, the deposit then takes place, and the coffee poured off ready for use. In order to separate the dregs more completely, the coffee may be passed through a clean cloth, but generally this is not necessary and often prejudicial to the pure flavor of the beverage.

The first boiling gives the strength, the second addition the flavor. The water does not dissolve more than the fourth part of the aromatic substances contained in the roasted coffee.

The beverage when ready ought to be of a brown black color, somewhat like chocolate thinned with water; this want of clearness in coffee thus prepared, does not come from the fine grounds, but from a peculiar fat resembling butter, about 12 per cent. of the amount the berries contain, and which, if over roasted, is partly destroyed.

In the other methods of making coffee, more than half of the valuable parts of the berries remain in the grounds, and is lost.

"Judging," said Liebig, "as favorably of my coffee as I do myself, its taste is not to be compared with that of the ordinary beverage, but the good effects which my coffee has on the organism should be taken into consideration.

Many persons who connect the idea of strength or concentration, with a dark color, fancy my coffee to be thin and weak, but these were at once more favorably inclined, when I gave it a dark color by means of burnt sugar."

Adulteration of coffee sold in a ground state, is largely carried on, especially of that sold to the poorer classes —out of 34 samples purchased by an English analytical chemist in London, 31 contained chickory, chickory itself being adulterated with all manner of compounds.

There is no falling back, says Dr. Hopall, upon tea and chocolate, as these seem rather worse off than the coffee. Tea is not only adulterated here, but in China, while as to chocolate, the processes employed in corrupting that manufacture, are described as "diabolical." It is often mixed with brick dust to the amount of 10 per cent., ochre 12 per cent., and peroxide of iron 22 per cent., and animal fats of the worst description, while the names "Flake," "Rock," "Granulated," "Soluble," "Dietetic," are merely employed as disguises to cover the fact that they are compounds of sugar, starch and other substances.

The microscope is the most effective instrument in the work of detecting adulterations, the microscopic appearance of coffee and chickory being very distinctive, while the presence of starch granules discovers the particular cereal employed in adulterations.

The adulteration of coffee by the addition of chicory is fraudulent but harmless, chickory containing little that is injurious to the system; coffee indeed is the more active substance of the two; its effects on some delicate constitutions being so strongly manifested, that without a violation of language, it may almost be designated a weak poison.

Some persons positively like the flavor of chickory, others detest it; its presence, however, can be at once detected by its peculiar odor, and if thrown into cold water it imparts a deep tint, which coffee does not.

In conclusion, I offer a useful receipt of Leibig's for preparing coffee in a ground form for special cases, such as marches and journeys, where it is inconvenient to be burdened with the necessary machines for roasting and grinding; by this process its aromatic properties can be preserved.

One pound of the roasted berries is reduced to powder, and immediately wetted with a syrup of sugar, obtained by pouring on three ounces of sugar, two ounces of water, and letting them stand a few minutes.

When the coffee powder is thoroughly wetted with the

syrup, two ounces of finely powdered sugar are to be added, mixed well with it, and the whole is then to be spread out in the air to dry. The sugar locks up the volatile parts of the coffee, so that when it is dry they cannot escape.

Ground coffee prepared in this way, and which lay exposed to the air for one month, yielded, on being boiled, as good a beverage as one made from freshly roasted berries.

I have described the mental influence of tea and coffee; much could be written on their influence upon modern society and civilization.

Anne Boleyn makes mention in one of her letters of having partaken of half a pound of bacon and a quart of beer for breakfast; now, after making due allowance for custom and habit, it must be confessed that modern ladies must rise from their morning meal of a cup of coffee with some bread and butter and an egg, with many different sensations and sentiments to those experienced by the fair Queen after her more masculine repast.

BACTERIA IN THE AIR.

M. Miquel has succeeded in seizing and numbering the spores or eggs of bacteria, and while confirming M. Pasteur's observation, that they are always present in the air, shows that their number presents incessant variations. Very small in winter, it increases in spring, is very high in summer and autumn, then sinks rapidly when frost sets in. This law also applies to spores of champignons; but while the spores of moulds are abundant in wet periods, the number of aërial bacteria then becomes very small, and it only rises again when drought pervades the soil, a time when the spores of moulds become rare. Thus, to the *maxima* of moulds correspond the *minima* of bacteria, and reciprocally. In summer and autumn, at Montsouris, one finds frequently 1,000 germs of bacteria in a cubic mètre of air. In winter the number not uncommonly descends to four and five, and on some days the dust from 200 litres of air proves incapable of causing infection of the most alterable liquors. In the interior of houses, and in the absence of mechanical movements raising dust from the surface of objects, the air becomes fertilizing only in a volume of 30 to 50 litres. In M. Miquel's laboratory, the dust of five litres usually serves to effect the alteration of neutral bouillon. In the Paris sewers infection of the same liquor is produced by the particles in one litre of air. These results differ considerably, it is pointed out, from those published by Tyndall, who says a few cubic centimètres of air will, in most cases, bring infection into the most diverse infusions. M. Miquel compared the number of deaths from contagious and epidemic diseases in Paris with the number of bacteria in the air during the period from December, 1879, to June, 1880, and certainly, each recrudescence of the aërial bacteria was followed at about eight days' interval by an increase of the deaths in question. Unwilling to say positively that this is more than a mere coincidence, he presents further observations regarding it. M. Miquel further finds (contrary to some authors) that the water-vapor which rises from the ground, from rivers, and from masses in full putrefaction is always micrographically pure; that gases from buried matter in course of decomposition are always exempt from bacteria; and that even impure air sent through putrefied meat, far from being charged with microbes, is entirely purified, provided only the putrid filter be in a state of moisture comparable to that of the earth at 0.30 metres from the surface of the ground.

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JOHN MICHELS, Editor.

Published at

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SATURDAY, AUGUST 14, 1880.

DEPARTMENT OF AGRICULTURE.

At a time when the English Government appears to be awakening to the necessity of systematically bringing the light of science to bear on the various important agricultural problems which are continually forced upon public notice, it is an agreeable task to examine the reports of the Department of Agriculture at Washington, and to note the practical usefulness of the work there taken in hand, and the thoroughness with which it is performed.

The recent reports refer to one of the most important successes of this Department, that of obtaining crystalizable sugar from maize plants, which may be grown in most sections of the United States. Congress at once appreciated the value of this discovery and directed the Commissioner of Agriculture to furnish a report giving all the information in his power in regard to the manufacture of sugar from sorghum, its cost, the character and expense of the machinery necessary, together with statistics of the consumption and production of sugar in the United States and all matters bearing on the subject.

In the reply, which was made *seriatim*, we learn that the Department has thirty-two varieties of sugar producing sorghums and millet plants, all more or less valuable, according to the varying soils, climate, cultivation, seasons and process of manufacture. From these they have selected four, which in their opinion are best adapted to the ends in view. The most useful of these is the Minnesota Early Amber, the juice of which is said to granulate more readily than other varieties. It ripens early, yields bountifully an excellent quality of syrup, and the farmers who have raised this variety of cane record their experiences as showing it to be better than any other variety. The Department of Agriculture commends it for use in the Northern part of the United States in latitudes above Chicago.

Below this latitude the White Liberian Cane may be planted as auxiliary to the Early Amber, while in the latitudes of St. Louis and the region south of it, Honduras Cane should be added to the other two varieties, thus extending the season for working the cane many weeks beyond the period that could be utilized, if but one variety were planted. The Chinese Sorgo Cane ripens about two weeks after the Early Amber.

As the methods employed in making sugar from these plants have been already described, we need only add that experiments by the chemist of the Department during the last two years have demonstrated that there is practically little if any difference in the juice of the several varieties; that they all produce sugar which can be easily granulated, if the cane be taken at the proper season of growth, and that the only important question yet to be determined is as to the variety that will yield the largest amount in a given soil and climate.

We understand that only "*a fair measure of success*" has attended the manufacture of sugar, in the manner now under description, by farmers on a small scale, and we cannot too strongly endorse the sensible advice which has been tendered, that farmers should merely convert the juice of the stalks into a syrup, and that large central mills be established where the syrup may be converted by proper vacuum pans and centrifugals.

These central mills would have the same relation to this industry that the grist mills of a neighborhood bear to wheat and corn.

The making of sugar entails a process requiring considerable practice and experience, and we are not surprised to find that farmers find many difficulties in the way of success, and it will certainly pay them better to sell the syrup, to be converted under the direction of experts. We understand that in the Western States a gallon of dense syrup weighing, say 13 pounds, can be produced for 16⅔ cents (possibly less). This, if properly managed, should yield 6 to 8 pounds of sugar, and, if handled by the centrifugal, may be separated at a fraction of one cent per pound.

If this method of co-operation is carried out, we see no reason why the 2,000,000,000 pounds of sugar annually used in the United States should not be grown and manufactured within its boundaries and by native industry.

HARVARD UNIVERSITY.

The following record of original work in progress at Harvard University, forms part of an interesting article by J. R. W. Hitchcock, A. B.:

In the last publication of the American Academy of Arts and Sciences, in which, by the way, seven of the eight papers are by Harvard investigators, appear the following "Propositions in Cosmical Physics," by Professor Benjamin Peirce:

1. All stellar light emanates from superheated gas. Hence the sun and stars are gaseous bodies.

2. Gaseous bodies, in the process of radiating light and heat, condense and become hotter throughout their mass.

3. It is probable that their surface would become colder if there were not an external supply of heat from the collision of meteors.

4. Large celestial bodies are constantly deriving superficial heat from the collision of meteors, till at length the surface becomes superheated gas, which constitution must finally extend through the mass.

5. Small celestial bodies are constantly cooling till they become invisible solid meteors.

6. The heat of space consists of two parts: first, that of radiation principally from the stars, which is small, except in the immediate vicinity of the stars; the second portion is derived from the velocity with which the meteors strike the planet at which the observation is taken; and this velocity partly depends upon the mass of the star by which the orbit of the planet is defined, and partly upon the mass of the planet itself.

7. If the planets were originally formed by the collision of meteors, it is difficult to account for an initial heat sufficient to liquefy them, and, at the same time, to account for their subsequent cooling without a great change in the number and nature of the meteors; and any such hypothesis seems to invalidate the meteoric theory.

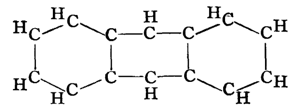
8. If the planets were not originally formed by the collision of meteors, their common direction of rotation becomes difficult of explanation.

Professor J. M. Peirce has recently published a set of "Mathematical Tables," in which the part relating to "Hyperbolic Functions" is entirely original. Other work in this department is represented by Professor Byerly's "Differential Calculus" and Mr. Wheeler's "Elementary Plane and Spherical Trigonometry."

The forbidding granite building called "Boylston Hall" conceals scenes of strange activity. Unwonted odors irritate the inexperienced nose of the visitor, and in the laboratories spectral shapes flit backward and forward behind clouds of vapor, occasionally lit up by lurid flames. These are the students; but in their private laboratories the professors pursue their own researches. Professor Cooke has been dealing with that unprincipled element, antimony, which has obdurately persisted in claiming two atomic weights, until he has successfully limited it to one. In connection with his laboratory-work, Professor Cooke is preparing a new edition of his "Chemical Philosophy." The results of his inorganic work have appeared from time to time in the publications of the Academy of Arts and Sciences.

Since the "Organic Laboratory" was established, in 1875, Professors Hill and Jackson have published twenty-five papers giving the results of their work, and have discovered one hundred new compounds. The discovery of new compounds, however, possesses as a rule no special importance, and is rather incidental to, than the result of, the main work. Two examples will indicate somewhat the character and object of organic investigations. The *composition* of uric acid has been long known to be $C_5H_4N_4O_3$, but its *constitution*—the exact arrangement of the atoms—has been uncertain. Chemists all over the world had endeavored to settle the question, but their failures resulted in eleven different formulæ for this one substance. Professor Hill, taking this uric acid $C_5H_4N_4O_3$, marked one part by replacing H by CH_3 (methyl); then treating the acid so as to split it up, he determined to which part the methyl was attached, and, by continuing his treatment, was enabled to reduce the possible formulæ from eleven to three, with strong probabilities in favor of one. This possesses a practical value, inasmuch as it will lead to a knowledge of the method of formation of uric acid in the animal body. Professor Hill's work on "Fur ferrol," found in the products of the distillation of wood, is interesting, as chlorophyll can probably be obtained from it.

An example of the curious subtleties of science is afforded by Professor Jackson's investigations of anthracene, which is obtained from coal-tar, and yields alizarine (madder-dye), used in dyeing pink and purple calicoes, Turkey reds, etc. Anthracene was known to consist of two hexagons of carbon with hydrogen atoms attached, united by two other carbon-atoms. Professor Jackson proved, by making anthracene artificially, that these two carbon-atoms are united to adjacent corners in each hexagon, thus:



These are but stray examples of the researches that are constantly being made by Professors Hill, Jackson, and their assistants. Brom-benzylbromides, parachlorbenzyls, and benzaldehyds, however fascinating they may be to chemists, would offer few charms to the general reader.

Since 1841 Dr. Asa Gray has devoted such leisure as he could command to his great work "The Flora of North America," a labor the magnitude of which only an experienced botanist can appreciate. Mr. Watson, Curator of the Herbarium, is assisting Professor Gray, and at present is classifying the flora of California. The new series of botanical text-books, edited by Dr. Gray, will shortly be completed. The titles will be as follows:

1. "Structure and Morphological Botany of Phænogamous Plants," by Dr. Gray.

2. "Physiological Botany" (Vegetable Histology and Physiology), by Dr. Goodale.

3. "Introduction to Cryptogamous Botany," by Professor Farlow.

4. "Natural Orders of Phænogamous Plants and their Special Morphological Classification, Distribution, Products," by Dr. Gray.

One of the most recent of Dr. Gray's botanical contributions to the Academy of Arts and Sciences was a paper on the "Characters of some New Species of Compositæ in the Mexican Collection, made by C. C. Parry and Edward Palmer," and a notice of "Some New North American Genera, Species, etc."

Professor Farlow's work in cryptogamic botany is doubly interesting on account of its direct practical application. At the Bussey Institution Professor Farlow has been investigating the diseases of plants, and latterly has been engaged upon algæ and fungi. Among his recent work is a paper on algæ for the United States Fish Commission, an examination of the causes of onion-smut and the diseases of trees for the Board of Agriculture, and an investigation of the algæ producing disagreeable tastes and smells in water, for the State Board of Health. His work resolves itself, speaking generally, into two kinds—one, the abstract descriptions and arrangements in families of algæ and fungi, and the other the detection of fungi in disease. As an example of the first, there is a European species of alga which constitutes the green scum on stagnant water. Several different varieties may be found in different places, but they have all been discovered to belong to the same family. To illustrate the second, there is a certain kind of fungus on cedar trees, but this has been ascertained to be only a first stage, and the fungus in its second stage is found upon several members of the apple family.

Professor Wolcott Gibbs has been carrying on researches on complex inorganic acids, and Professors Lovering and Trowbridge have been conducting purely physical investigations. Professor Trowbridge has introduced a method of instruction that necessitates a large amount of original research on the part of his students. This consists of lectures, given by the students instead of by the instructor, to the class. Although all the work at the Observatory really comes under the head of original investigation, the observations constantly taken in connection with the Observatory Time Service resolve themselves into mere routine work. An immediate and practical benefit is conferred

by this Time Service, the signals of which reach Bangor, Lennoxville, in Canada, Albany, and New York, as well as different points in Massachusetts. The copper time-ball, held by a powerful electro-magnet at the top of the mast on the Equitable Life Assurance Building, Boston, is released at noon by the clock at Cambridge. During 1879 accidents caused a small error in its fall on two days only, and on three days it has been dropped at 12h. 5 m. os.

The great equatorial of fifteen inches' aperture and the meridian circle whose telescope has an aperture of eight inches have been kept actively in use for the last three years. The former instrument has been devoted almost entirely to photometric work. The problem of astronomical photometry, roughly stated, is to determine the brightness of all the heavenly bodies, so that all may be compared with a single standard. Previous to the beginning of this work at the Harvard Observatory, photometric measurements had been made almost entirely upon the planets and brighter stars, and there was no definite knowledge of the amount of light emitted by the satellites and fainter stars. At the outset of the work several hundred measurements were taken of the brightness of the outer and inner satellites of Mars, which measures have been taken accurately nowhere else. The satellites of Jupiter and Saturn, including Hyperion, the faintest of Saturn's satellites, were similarly measured. In addition to measuring their brightness, a large number of determinations of the positions of the satellites were made. A comparison was also begun of the light of the sun and stars, with the idea of reducing all photometric measurements to a common standard—the light of the sun. This photometric work has been continued until the light of all the known satellites, except the two inner satellites of Uranus, has been measured.

One of the most important series of equatorial observations has been in connection with the eclipses of Jupiter's satellites. These phenomena have proved exceedingly valuable as a means not only of determining the orbits of the satellites themselves, but of measuring the distance of the sun or the velocity of light, and of obtaining terrestrial longitudes.

The observations of the mere appearance or disappearance of a satellite, however, can not be rendered sufficiently exact, and, to lessen the errors, photometric observations have been made of the satellites as they gradually enter or emerge from the shadow of Jupiter, using the planet itself or another sate lite as a standard.

In order to furnish means for the comparison of the scales of stellar magnitude, employed by different astronomers in their estimate of the brightness of faint stars, a number of faint stars in the immediate neighborhood of the north pole were selected for photometric measurement, and a circular was distributed among astronomers requesting estimates of magnitudes of the same stars for comparison with such other, and with the results of the measurements made here. A series of measurements of all the planetary nebulæ has also been undertaken. This work with the great equatorial has necessitated the invention of a number of new photometric instruments, which have been devised by Professor Pickering and his assistants.

For nearly eight years Professor Rogers has been engaged upon one of the largest astronomical undertakings that has been successfully completed in this country. This is the observation with the meridian circle of the zone of eight thousand stars, between fifty and fifty-five degrees north, undertaken by this Observatory as its share in the determination of the position of the stars of the northern hemisphere. The observations were finished about a year ago, but some years will be required to complete the reduction and publication of this work.

The total number of observations for 1879 with the meridian circle, including about six hundred for the Coast Survey, was nearly three thousand. The scientists at the Observatory are now engaged in the task of determining the light of all the stars visible to the naked eye in the latitude of Cambridge. The meridian is used in observations like a transit instrument in connection with a new and elaborately designed photometer.

At the Museum of Comparative Zoology the staff of specialists is almost entirely occupied in the classification and arrangement of different collections and the publication of the results of their researches. The most important accessions during 1878 and 1879 are the extensive collections of the Blake dredging expedition, and the collections of birds, mammals, reptiles, and fishes, made by Mr. Garman at St. Kitts, Dominica, Grenada, Trinidad, St. Thomas, and Porto Rico, after he left the Blake. The Blake collections and specimens from the entomological, conchological, and ornithological departments are in the hands of well-known specialists for final investigation. Of the extensive work in progress it is impossible to give any details. The results are embodied in the extensive publications of the museum. Five volumes of bulletins have been published, averaging about a dozen papers each. The quarto publications will hereafter be issued as memoirs. The catalogues thus far published have been collected into Volumes I.–IV. of the memoirs. Five volumes of memoirs and the first part of the sixth have already appeared. The second part of the sixth and Vol. VII. are now in course of preparation or in press. Vol. VI. contains the great work upon which Professor Whitney is now engaged, "The Auriferous Gravels of the Sierra Nevada of California." The Sturgis Hooper Professorship of Geology, held by Professor Whitney, is noticeable as being founded solely for original research.

The dredging operations of the Coast Survey steamer Blake have not only aided zoological science by the information obtained in regard to echini, corals, crinoids, ophiurians, worms, hydroids, and others, but have added to geographical knowledge of the Caribbean Sea by showing the changes in form and distribution of lands along various groups of islands, and in the form of the land beneath the water. Professor Agassiz considers the deep-sea collections of the Blake the largest and most important ever made on this coast, and, when combined with the results of other expeditions sent out under the auspices of the Coast Survey, they make the collections at the museum but little inferior to those of the Challenger. During the coming summer Professor Agassiz will probably undertake another dredging trip in the Blake, following the course of the Gulf Stream to the north of the Bahamas, and dredging from the 100 to the 2,500 fathom line off the coast of the United States, so as to connect the isolated district with the deep-water fauna proper of the Atlantic.

Professor N. S. Shaler, Professor of Paleontology, in addition to his work at the museum, and as an instructor, has, since 1873, had charge of the Kentucky State Survey. Four volumes of reports and one of memoirs have been already completed, and one volume of memoirs and nine of reports are now in press. The recent writings of Professor Shaler are "The Origin and Nature of Intellectual Property," and several articles in the "Proceedings of the Boston Natural History Society," "The Atlantic Monthly," and "The International Review." The article by Professor Shaler in the latter magazine is entitled "Sleep and Dreams."

Scientific publications, based entirely or in part upon the entomological collection of the museum, are the new edition of the "Catalogue of the Diptera of the United States," by Osten-Sacken, published by the Smithsonian Institution, Part VIII. of the "Monographic Revision of the European Trichoptera," by R. McLachlan, published in London, and several papers by Dr. H. A. Hagen, the head of the department.

At the medical school the largest amount of original investigation is carried on in the physiological and chemical laboratories. In the former a number of new forms of apparatus are in use, which have been designed by Professor Bowditch and his assistants. Among these are an apparatus for keeping animals alive by artificial respiration; a dog-holder, canulæ for observations on the vocal cords of animals, without interfering with their natural respiration; unpolarizable electrodes used in studying certain problems in the physiology of the nervous system; a new form of apparatus for barometric measurements; and a novel plan for measuring the volume of air inspired and expelled in respiration. A new form of plethysmograph has been devised by Dr. Bowditch. This is an instrument for measing the changes in the size of organs, either hollow or solid, which are produced by variations in the conditions to which they are subjected. The essential part of Dr. Bowditch's invention is a contrivance by which fluid is allowed to flow freely to and from the organ to be measured without changing its absolute level in the receptacle into

which it flows, while at the same time a record is made of the volume of the fluid thus displaced.

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another specimen was sent to this University from Santa Aña in the same section of the country by a resident who stated in his letter that on throwing a match upon the ground he was surprised to see these rocks take fire and burn. He therefore sent a piece to be examined.

The specimens furnished to Mr. Redding were examined by me and the result published in the above mentioned article. The substance, which was extremely light, white and porous, almost chalky, was shown to be mainly a well-marked resin, leaving but a trace of an ash on combustion. No theory was advanced as to its origin, and attention was called simply to its structure :—"On fracture it presents a slightly fibrous structure. Under the microscope it exhibits a two-fold structure—a quantity of very fine, irregular fibers permeating a mass of a brittle, amorphous, structureless substance." Since that paper was written I have endeavored to obtain more definite information as to the origin and occurrence of this peculiar substance. The region of its occurrence is so remote and so inaccessible that it has been impossible for me to investigate the matter in person, and difficult to find competent persons whose business takes them into that region. However, from reports obtained through the agency of Mr. Redding, I feel tolerably confident that the true nature and origin of this substance has been cleared up.

It seems that there grows, and probably has grown for a long time, a species of conifer which exudes large masses of a resinous secretion from abrasions or wounds. These resinous masses are reported to attain considerable size, and to fall off from their own weight. However that may be, the detached resin either from fallen and decayed trees, or from living trees, becomes scattered over the surface of the country and mixed with surface soil and rocks. By a long process of evaporation, action of atmosphere, and the leeching and bleaching agency of the snow which covers the ground for a large portion of the year, these resinous masses lose all vestiges of volatile and soluble matter, and at the same time a fungus growth permeates and splinters the whole mass into minute fragments rendered coherent by the fibers of the fungus. Hence the two-fold structure noted, the fungus growth as shown in the previous paper, amounting to less than 10 per cent of the mass.

The perfect change which has taken place in the resin by these agencies evidence that the resin must have been exposed for an indefinite period to atmospheric agencies, and have attained a position of equilibrium toward its surrounding conditions. It is therefore apparently entirely a surface formation, which however has in process of time become so mixed in with surface soil and rocks as in some instances to present the appearance of being *in situ*. (*American Journal of Science*.)

UNIVERSITY OF CALIFORNIA, May, 1880.

EDUCATION OF YOUNG ASTRONOMERS.

France has of late shown a greatly increased activity in astronomical work, both in the improvement of existing, and the institution of new, observatories. The question of how to provide these with men thoroughly competent to carry on the work has come prominently forward.

Hitherto, the recruiting of the observatories has taken place in the most irregular manner, and without the help of any special schools, such as are provided for other scientific careers. The candidates who have presented themselves have often neither possessed the theoretical knowledge, nor the ardor and special aptitude necessary for a career so difficult.

At the Paris Observatory, where the staff is the most numerous, and the *matériel* of instruments most complete, a certain amount of practical instruction could be given, but this only at the expense of the ordinary service, and through the goodwill of the older officials, whose regulations did not comprise this surplus work.

But in provincial observatories education has been more difficult, if not impossible. From lack of funds, it is unfortunately often the astronomical professor of the local faculty who is also director of the observatory, and he has to divide his time between these two functions. Sometimes, too, this director, an excellent professor of mathematics and celestial mechanics, has not been sufficiently initiated in the practice of the very delicate observations of astronomy requiring much experience and skill. Lastly, the *matériel* of these observatories has remained hitherto in a state of regretable inferiority, which could hardly inspire the observers with zeal. It will be readily understood, then, how the number of astronomical observers has been very limited, to the prejudice of astronomical work and discovery in France. This is the more regretted since that country has not been wanting in great geometers, who have remarkably promoted the arduous science of celestial mechanics; the illustrious names of Laplace and Leverrier will here readily occur.

It was, then, an urgent matter to form as soon as possible a superior school of practical astronomy, and with this view a ministerial decree has recently been promulgated. With candidates carefully selected and instructed for some time in a systematic way under masters of the science, a number of able astronomers may be looked for, competent to make a good use of the excellent instruments and opportunities that are now being plentifully provided.

The duration of the studies (to be carried on in Paris) will be two years. The first year will be chiefly devoted to the theoretical and practical study of the meridian service, the fundamental base of the astronomy of observation, and to the use of portable instruments, comprising those with reflection, for it is necessary that every astronomer in an observatory should be capable of teaching the use of instruments employed in traveling, and methods of observation, to the explorers, now so numerous, who, on leaving, seek preparatory instruction, the determination of latitudes and longitudes, &c., in the course of their travels. The second year will be devoted to service of equatorials and physical astronomy. The first half of each year will be occupied in lectures, studies, and exercises. During the second half, the students will make the regular service of observations along with the officials of the observatory.

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Moreover, MM. Jamin and Desains, the eminent professors of the Sorbonne, will open their physical laboratories to the young astronomers, and direct them in their studies and the management of instruments and various experiments which may interest them, and facilitate their labors in physical astronomy. M. Mascart, director of the central meteorological office, will also put them *au courant* with recent progress accomplished by meteorological science and service.

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THE science of human life has been the last to recognize that minute interaction of all the sciences which every other department of knowledge now readily admits. We allow at once that no man can be a good physiologist unless he posesses a previous acquaintance with anatomy and chemistry. The chemist, in turn, must know something of physics, while the physicist cannot move a step until he calls in the mathematician to his aid. Astronomy long appeared to be an isolated study, requiring nothing more than geometrical or arithmetical skill; but spectrum analysis has lately shown us its intimate interdependence upon chemistry and experimental physics. Thus, the whole circle of the sciences has become a continuous chain of cycles and epicycles, rather than a simple sequence of unconnected and independent principles.—PROF. GRANT ALLEN, *Popular Science Monthly*.

another specimen was sent to this University from Santa Aña in the same section of the country by a resident who stated in his letter that on throwing a match upon the ground he was surprised to see these rocks take fire and burn. He therefore sent a piece to be examined.

The specimens furnished to Mr. Redding were examined by me and the result published in the above mentioned article. The substance, which was extremely light, white and porous, almost chalky, was shown to be mainly a well-marked resin, leaving but a trace of an ash on combustion. No theory was advanced as to its origin, and attention was called simply to its structure:—"On fracture it presents a slightly fibrous structure. Under the microscope it exhibits a two-fold structure—a quantity of very fine, irregular fibers permeating a mass of a brittle, amorphous, structureless substance." Since that paper was written I have endeavored to obtain more definite information as to the origin and occurrence of this peculiar substance. The region of its occurrence is so remote and so inaccessible that it has been impossible for me to investigate the matter in person, and difficult to find competent persons whose business takes them into that region. However, from reports obtained through the agency of Mr. Redding, I feel tolerably confident that the true nature and origin of this substance has been cleared up.

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ON A PHOTOGRAPH OF JUPITER'S SPECTRUM, SHOWING EVIDENCE OF INTRINSIC LIGHT FROM THAT PLANET.

By Professor Henry Draper, M. D.*

There has been for some years a discussion as to whether the planet Jupiter shone to any perceptible extent by his own intrinsic light, or whether the illumination was altogether derived from the sun. Some facts seem to point to the conclusion that it is not improbable that Jupiter is still hot enough to give out light, though perhaps only in a periodic or eruptive manner.

It is obvious that spectroscopic investigations may be usefully employed in the examination of this question, and I have incidentally, in the progress of an allied inquiry,[1] made a photograph which has sufficient interest to be submitted to the inspection of the Astronomical Society.

If the light of Jupiter be in large part the result of his own incandescence, it is certain that the spectrum must differ from that of the sun, unless the improbable hypothesis be advanced that the same elements, in the same proportions and under the same physical conditions, are present in both bodies. Most of the photographs I have made of the spectrum of Jupiter answer this question decidedly, and from their close resemblance to the spectrum of the sun indicate that, under the average circumstances of observation, almost all the light coming to the earth from Jupiter must be merely reflected light originating in the sun. For this reason I have used the spectrum of Jupiter as a reference on many of my stellar spectrum photographs.

But on one occasion, viz.: on September 27, 1879, a spectrum of Jupiter with a comparison spectrum of the moon was obtained which shows a different state of things. Fortunately, owing to the assiduous assistance of my wife, I have a good record of the circumstances under which this photograph was taken, and this will make it possible to connect the aspect of Jupiter at the time, with the spectrum photograph, though I did not examine Jupiter with any care through the telescope that night, and indeed did not have my attention attracted to this photograph till some time afterwards.

I send herewith to the Astronomical Society for examination the original negative which is just as it was produced, except that it has been cemented with Canada balsam to another piece of glass for protection. Attached to the photograph is an explanatory diagram, intended to point out the peculiarities which are of interest. It will be noticed at once that the main difference is not due to a change in the number or arrangement of the Fraunhofer lines, but rather to a variation in the strength of the background. In the case of the moon the background is uniform across the width of the spectrum in any region, but in the case of Jupiter the background is fainter in the middle of the width of the spectrum in the region above the line *h*, and stronger in the middle in the region below *h*, especially towards F. The observer must not be confused by the dark portion where the two spectra overlap along the middle of the combined photograph.

In order to interpret this photograph it must be understood that the spectrum of Jupiter was produced from an image of the planet thrown through the slit of the spectroscope, by a telescope of 183 inches focal length, the slit being placed approximately in the direction of a line joining the poles of the planet. The spectroscope did not, therefore, integrate the light of the whole disk, but analyzed a band at right angles to the equator and extending across the disk. If either absorption or production of light were taking place on that portion of Jupiter's surface there might be a modification in the intensity of the general background of the photographed spectrum.

A casual inspection will satisfy any one that such modifications in the intensity of the background are readily perceptible in the original negative. They seem to me to point out two things that are occurring: first, an absorption of solar light in the equatorial regions of the planet; and second, a production of intrinsic light at the same place. We can reconcile these apparently opposing statements by the hypothesis that the temperature of the incandescent substances producing light at the equatorial regions of Jupiter did not suffice for the emission of the more refrangible rays, and that there were present materials which absorbed those rays from the sunlight falling on the planet.

If the spectrum photograph exhibited only the absorption phenomenon above *h*, the interest attached to it would not be great because a physicist will readily admit from theoretical considerations that such might be the case owing to the colored belts of the planet. But the strengthening of the spectrum between *h* and F in the portions answering to the vicinity of the equatorial regions of Jupiter bears so directly on the problem of the physical condition of the planet as to incandescence that its importance cannot be overrated.

The circumstances under which this photograph was taken were as follows: Longitude of observatory $4^h\ 65^m\ 29^s{\cdot}7$ west of Greenwich. Night not very steady. Jupiter and the moon differed but little in altitude. Jupiter's spectrum was exposed to the photographic plate for fifty minutes, the moon was exposed for ten minutes. Jupiter was near the meridian. The photograph of Jupiter's spectrum was taken between $9^h\ 55^m$ and $10^h\ 45^m$, New York mean time, September 27, 1879.

I have suspected that perhaps there may have been an influence produced by the great colored patch on Jupiter which has made itself felt in this photograph. It may be that eruptions of heated gases and vapors of various composition, color, and intensity of incandescence are taking place on the great planet, and a spot which would not be especially conspicuous from its tint to the eye might readily modify the spectrum in the manner spoken of above.

SECULAR CHANGES IN THE EARTH'S FIGURE.

An interesting hypothesis has been promulgated before the French Academy by M. Faye. It has long been known from geodetic surveys and pendulum experiments that contingents and mountain ranges do not exert that attraction on the pendulum which might be expected of them, judging from the observed attraction of such isolated masses as Mount Schehallion, in Scotland, or the great pyramid. In fact, the deficiency of mountains in this respect is so striking that in order to account for it geologists and astronomers have imagined that there are vast cavities underlying continents and mountain chains. A somewhat different explanation of the feeble action of Himalayas on the pendulum has been offered by Sir George B. Airy, who supposes that the attraction of the mountains is counteracted by still fluid lakes of rock below them. But this suggestion does not meet the fact, elicited by M. Saigey, that the attraction on islands of the sea is greater than it ought to be. It appears to be clear, however, that there is a relative lack of matter under continents, and an excess of it under oceans. The hypothesis of M. Faye would seem to solve the problem in a very simple and reasonable manner. He holds that under the sea the earth's crust has cooled much more quickly than under dry land, and hence the solid sea-bed is denser and thicker than the sub-continental mass. Water is a good conductor of heat as compared with rock, and being liquid it is also able to convey heat from its underlying basin. Geodesy shows that the present figure of the earth is an ellipsoid of revolution; but if M. Faye's hypothesis be correct, it has not always been so. At first it was an ellipsoid, but the unequal cooling of the earth, due to the liquid mantle covering it, led to unequal stress and the elevation of continents where the crust was thinner. These continents, according to M. Faye, surrounded the north pole, and the level of the ocean over our hemisphere was raised, thus bringing the earth to a more spheroidal form. Finally, as the cooling continued, the austral continents attracted the oceans, and the figure became once more elipsoidal, as it is to-day. If this ingenious speculation were the true one, it would unquestionably help geologists to explain the origin of the glacial period.—*Engineering*.

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TRANSLATIONS.

M. Stroh presented to the *Société des Ingénieurs Telegraphistes de Londres* a very interesting memoir upon the measurement of the adhesion which occurs when a voltaic current of a certain intensity is made to pass between two metals of the same nature. The author of this remarkable paper has also devised a special instrument for the purpose of measuring the force necessary to separate the adherent metals. It is perhaps not inopportune to remark here that this adhesion should be considered as a disturbing force in many experiments, and especially in telegraphy. The measurement of the amount of force required to overcome the adhesion gave the following results expressed in grammes:

Copper	0.15	Zinc	11.	Platinum	42.
Silver	0.15	Tin	14.	Iron	85.
Alluminium	2.50	Gold	17.	Steel	100.
Bronze	8.50	Lead	18.	Tempered Steel	225

When contact takes place between two different metals, the force of adhesion appears to correspond with that of the metal requiring the least force for its separation. Thus the adhesion of tin with iron would require 14 grammes for separation, the corresponding figure for tin, and not that of iron, which is 85. The importance of this matter is quite obvious, and seems to be well worthy of complete investigation. On microscopical examination of the two surfaces placed in contact, M. Stroh finds that the adhesion always arises from the fusion of the superficial layer by the electrical current.—*L'Electricité.*

WATER JETS AS A SOURCE OF ELECTRICITY.

Mr. J. Elster, a pupil of the celebrated Professor Quincke, is about to present a thesis, at Leipzig, upon this interesting question. The following, according to the *Journal Philosophique*, are the conclusions to which this young *savant* has arrived:

If any electro-motor force whatever is produced by a jet of water, there must have been contact of the particles of the water with a solid body. This condition proves that the electro-motor force is produced by the friction of the particles of water with the metal, so that only a small portion of the liquid contributes to the production of electricity.

Furthermore, when the rapidity of the water jet is increased or diminished, the effect obtained is proportional to the active force of the particles of the liquid, and depends also upon the nature of the body placed in contact with the water.

This theory seems to be very similar to that by which Faraday explained the production of electricity in the Armstrong machine. The conclusions reached by the author are opposed to those of many *savants*, notably the Swedish electrician, Ed. Lund.

1. The movement of a liquid, of itself, cannot produce electro-motor force.

2. The currents called electro-capillary are in the same case whether the fluid moistens or does not moisten the walls of the tube. In the first case the friction takes place between the adherent portion of the liquid and the molecules in motion. In the second case, the molecules of the liquid rub distinctly against the sides of the tubes.

Finally, his conclusion is that the electro-capillary currents, which he claims were discovered by Professor Quincke, are identical with the currents developed by friction, which have been demonstrated by Zollner on the rubber of electrical machines.—*L'Electricité.*

A NEW ELECTRIC PILE.

M. Reynier has devised a hydro-electric pile, comparable in energy, to the nitric acid couple, without its inconveniences. The zinc is immersed in a solution of caustic soda. The porous cup is made of parchment paper. The new couple is about twice as strong as the ordinary Bunsen couple, and is surpassed only by the rectangular Bunsen couple (after the model of Ruhmkorff). M. Becquerel, Sr., has already used a similar pile.—*La Science pour Tous.*

THE METRIC SYSTEM.

To the Editor of Science.

In connection with Prof. Ward's able "Plea for the Metric System in Microscopy," in SCIENCE for July 31st, it may be well to state that the "American Metric Bureau," of Boston, 32 Hawley street, has for some years been advocating the general use of the system, not only by publication of "The Metric Primer," and of various circulars and bulletins, but in the very practical way of supplying standard metric articles at much less than ordinary prices. As Prof. Ward well says, "the way to introduce the metric system is to use it ourselves," and judging by the experience of the students in my laboratory, who are advised not even to name the antiquated weights and measures, a pocket or desk rule is a more convincing argument than exhortation.

BURT G. WILDER.

GENERAL NOTES.

THE transformation of alcoholic liquids into vinegar has long been a matter of discussion. Pasteur holds that the formation of vinegar is a physiological phenomenon caused by vegetation of a particular bacterium, the *Mycoderma aceti*, while Liebig sees in it merely a chemical action of oxygen on alcohol. Recent observations by Herr Wurm, at the Breslau Institute of Plant-Physiology, are regarded as putting the former view beyond a doubt, and Herr Wurm has succeeded in effecting the industrial manufacture of vinegar in accordance with Pasteur's idea.

MR. BISSINGER, M. E., at Carlsruhe, Germany, gives the following results as obtained in his examinations of the several motors in regard to their relative cost per horsepower for each hour. It will be observed that the examination pertained principally to small motors. The relative cost per effective horse-power per hour is as follows:

100 h.-p.	steam engine	7.6
2 "	"	44.3
2 "	Lehmann's caloric engine	26.5
2 "	Hock's motor	40.0
2 "	Otto gas engine	26.4
2 "	Otto Lang gas engine	26.4
2 "	Schmidt's hydraulic motor, supplied with water from the city waterworks	95.00
2 "	obtained by horses and a gin	45.00
2 "	obtained by manual labor	200.00

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